Energy Management Services Guidelines
for Calculating Energy Saving for Renewable Energy Projects[1]

Public agencies are allowed to use energy management services (performance contracting) for installation of renewable energy projects that reduce facility energy costs and related operation and maintenance expenses. The term "renewable energy" refers to sources of energy that are regenerated by nature and sustainable in supply.

The "performance" aspect of performance contracting refers to energy performance and drives the way in which savings are determined. Since the measurement and verification (M&V) approach calculates and documents energy savings, it is one of the most important activities associated with implementing performance contracts and is a crucial issue in contract negotiations.

Renewable energy projects involve the installation of devices and/or systems that generate energy (e.g., electricity or heat) or displace energy use through the use of renewable energy resources. Examples of technologies include: photovoltaics (PV), active or passive solar systems for space conditioning or production of domestic hot water, and wind systems. For additional information on the measurement and verification of renewable energy projects, refer to IPMVP for renewables.[2]

The most notable difference between renewable energy projects and other energy conservation measures (ECMs) is that renewable projects supply energy rather than reduce the amount of energy used. Measuring the energy supplied allows for a simplified approach to measuring savings that is not possible with energy efficiency projects. Option B deserves special consideration when evaluating M&V options for renewable energy projects.

Like many projects, the performance of most renewable energy technologies depends on the environmental conditions, such as solar radiation or wind speed. The use of long-term averages of these values is reliable, but any M&V Plan should be structured in such a way as to allocate the risk due to short-term variations in environmental conditions. Therefore, it may be appropriate to stipulate these conditions and verify the performance of the equipment using short-term measurements (e.g., the efficiency of a solar hot water heater). Long-term performance typically needs to be verified.

Savings Calculations

There are two general approaches for calculating energy savings from renewable energy projects:

1. Net energy use

2. Normalized savings based on typical environmental conditions and actual performance characteristics

For all renewable energy projects, consideration should be given to the impact of parasitic energy use by the renewable system and to increased operations and maintenance costs due to the addition of new equipment. Demand savings from renewable energy technologies may occur, but, depending on the electric utility's rate structure, the energy must be available and uninterrupted during all peak periods. Accounting for demand savings requires more sophisticated metering that aligns measurement intervals with the utility interval.

1. ***Net Energy Use***

    The first approach involves directly measuring the energy output from the system and quantifying any

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[1] Source: *M&V Guidelines: Measurement and Verification for Federal Energy Projects Version 3.0*
[2] International Performance Measurement & Verification Protocol: Concepts and Practices for determining Energy Savings in Renewable Energy Technologies Applications, Volume II, August 2003.

additional costs incurred or savings realized. This approach is suitable for wind, PV, and other electricity generating equipment. The measurement concept assumes that energy (electrical and/or thermal) produced by the renewable system is used at the project site, and displaces energy that would have been provided by an existing source. Savings are determined by measuring the net amount of energy produced by the renewable system and used at the project site valued at prescribed utility rates. This approach eliminates the need for a baseline and places the risk of weather variations on the ESCO.

Utility savings from renewable measures that supply thermal energy (e.g., solar hot water heater) are determined by dividing the energy delivered by the efficiency of the original equipment (e.g., conventional water heater). For projects that may sell excess energy or store energy on-site, additional costs and savings may need to be considered. Cost savings using this approach can be calculated using the following equation.

Cost Savings Determination Utilizing Net Energy Use

$$CostSavings = (kWh \quad Delivered) \times (Rate_{kWh}) + \{ \frac{(ThermalEnergy)}{EfficiencyDisplacedEquipment} \}$$

$$\times (\frac{1kWh}{3,413BTU}) \times (Rate_{kWh}) + \{\$_{EnergySold}\} - \{\$_{ParasiticLoads}\} - \{\$_{New \ O\&MCosts}\}$$

Where:

kWh Delivered	=	Electrical energy delivered by the system and used at the facility
Rate$_{kWh}$	=	Specified cost of electrical energy
Thermal Energy	=	Thermal energy delivered by the system in Btu during the performance period
Efficiency Displaced Equipment	=	Operating efficiency of the equipment that would have been used
1kWh/3,414 Btu	=	Conversion between thermal energy (Btu) and electrical energy (kWh)
$\$_{Energy Sold}$	=	Funds received through the sale of energy produced
$\$_{Parasitic Loads}$	=	Cost of operating systems and equipment related to renewable technology
$\$_{New O\&M Costs}$	=	Additional cost of operations and maintenance due to renewable technology

2. *Normalized Savings*

The second primary approach involves calculating normalized savings based on typical environmental conditions and actual performance characteristics of the system. Savings are determined by calculating the difference between baseline energy and demand and predicted or metered energy and demand, with both sets of data adjusted to a prescribed set of conditions. Depending on the type of system, this strategy can use any of the four M&V options.

Normalizing savings in this manor places the risk of weather fluctuations on the federal agency, and requires that the ESCO periodically demonstrate that specified performance characteristics have been met. These performance characteristics and how they will be determined should be specified in the project-specific M&V Plan. Performance parameters that should be specified include efficiency of PV modules, minimum hot-water temperatures, and the content in landfill gases.

The basic energy savings equation (Equation 2-1) can be modified to determine cost savings, as shown in following equation.

General Savings Equation for Renewable Energy Projects

$$CostSavings = [\{(Baseline\ \ Energy) - (Performance\ \ Period\ \ \ Energy) \pm Adjustments\} \times (Rate_{Energy})] - \{\$_{ParasiticLoads}\} - \{\$_{New\ O\&MCosts}\}$$

Where:

Baseline Energy	=	The calculated or measured energy use of a piece of equipment prior to the implementation of the project
Performance Period Energy	=	The calculated or measured energy use of a piece of equipment after the implementation of the project
Adjustments	=	Routine and non-routine changes made to the baseline or performance period energy use to account for expected and unexpected variations in conditions
Rate$_{kWh}$	=	Specified cost of electrical energy
Thermal Energy	=	Thermal energy delivered by the system in Btu during the post-installation period
$\$_{Parasitic\ Loads}$	=	Cost of operating systems and equipment related to renewable technology
$\$_{New\ O\&M\ Costs}$	=	Additional cost of operations and maintenance due to renewable technology

Energy Metering

Determining the electrical output of systems is relatively straightforward. This is because electrical output and parasitic loads can be simply measured with many commercially available meters. Measuring thermal output (e.g., hot water from a domestic hot-water solar system displacing an electric water heating system) is also straightforward, but not necessarily inexpensive, using commercial Btu meters, water flow meters, temperature transducers, etc. However, all of the thermal and electrical output from a system does not necessarily displace an equivalent amount of load. This is due to storage, system losses, and differences in time between when useful energy is produced and when it is needed.

1. *Electrical Metering*

   Electricity measurements associated with system output, parasitic loads, power to the project site, and power to third parties and the utility may be needed. All electrical meters (and related equipment) are usually provided, installed, owned, and maintained by the ESCO or the servicing utility.

   When a net metering approach is used, meter(s) will typically show the measure's gross output (in kW and kWh) less parasitic use (e.g., pump motors) and sales to third parties or the local utility, as well as any local transformation and transmission and battery storage losses. The goal with this method is usually to measure net generation delivered to the project site. Metering, interconnection (including safety provisions), reporting, and other related issues are to be in accordance with current electrical standards and the requirements of the servicing electric utility.

   With the net energy-use M&V approach, deliveries to and from the facility should be separately recorded and treated as separate transactions. For purposes of power delivered to the site, a single meter that records energy supplied to the site is preferred. If a calculated transformer loss value is used, it should be based on certified factory test data for that particular transformer.

   The following are some suggested metering requirements:

   - kWh and demand metering at the point of delivery
   - Time of-delivery metering
   - Provisions for remote meter reading

2. *Thermal Metering*

Thermal meters (e.g., Btu meters) are required for measuring the net thermal output of certain renewable energy systems (e.g., hot water generated by an active solar system). Note that metering of thermal energy requires a "net" measurement of flows and enthalpy to and from a system. Measurements of thermal flows may need to take into account any vented or wasted energy that is produced by the system but not used at the site, as well as distribution and storage losses. Also note that small errors in enthalpy measurements (usually determined by temperature) can introduce large errors in the energy calculations; hence, meter precision, accuracy, and calibration are especially important.

Notes on Some Renewable Energy Technologies

1. *Active Solar Thermal Systems*

Active solar thermal systems include systems for producing industrial process heat, domestic hot water, and space heating and cooling. Useful monitoring includes 1) site inspections and brief temperature and system monitoring for diagnostics, 2) spot, short-term, or long-term monitoring of system key parameters such as temperatures, energy flows, and control status, and 3) utility billing analyses.

2. *Passive Solar Systems*

Passive solar systems usually involve the performance of a whole building with architectural features such as overhang design and use of thermal mass. As such, this technology is different from other renewable energy measures in that mechanical devices with identifiable energy inputs and outputs are not involved. Thus, passive solar M&V typically involves the analysis of a whole building, and thus it is best to use utility billing analyses or calibrated simulation techniques, i.e., Options C or D.

3. *Wind, PV, and Other Renewable Generation Projects*

With these types of systems, the performance characteristics of the components are usually well defined, such as the conversion efficiency of the PV modules or the Btu content of landfill gas. In addition, the electrical or thermal flows can usually be easily measured and Option B is typically utilized. The complexity of these projects lies in projecting long-term performance due to variation in the resources (e.g., solar insolation, wind resource, or reserve of methane gas in a landfill) and accounting for any variations between when the resource is available and when it is needed (i.e., the interaction of storage systems and their inefficiencies).